Rosalie with Papa's best love — 1862

11

BIOGRAPHY

OF

Dr. SHERIDAN MUSPRATT

F.R.S.E., M.R.I.A., F.C.S.,

Professor of the College of Chemistry, Liverpool.

By

A LONDON BARRISTER-AT-LAW,

Richard Brinsley Knowles

Son of James Sheridan Knowles

AND A THIRD EDITION OF

THE INFLUENCE OF CHEMISTRY

IN THE

ANIMAL, VEGETAL & MINERAL KINGDOM

By

Dr. SHERIDAN MUSPRATT.

LONDON: JOHN CHURCHILL, PRINCES STREET, SOHO.

1852

PRINTED BY HEWITT AND CO., STRAND.

Sheridan Muspratt

PROFESSOR MUSPRATT, F. R. S. E.

College of Chemistry, Liverpool,
Doctor of Philosophy,
and Membre de la Societé D'Encouragement.

Hewitt & Co Strand, London.

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F.R.S.E., M.R.I.A., F.C.S.,

MEMBRE DE LA SOCIETE D'ENCOURAGEMENT,

PROFESSOR OF

THE COLLEGE OF CHEMISTRY, LIVERPOOL,

AUTHOR OF

WORKS ON THE BLOWPIPE; QUALITATIVE ANALYSIS FOR LABORATORY PRACTICE; THE INFLUENCE OF CHEMISTRY, ETC.

WRITTEN FOR THE "LANCET,"

BY A LONDON BARRISTER-AT-LAW.

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PREFACE.

At a period when Chemistry, together with other branches of Natural Philosophy, is estimated in proportion to its practical results and the influence it exerts over the well-being of society, no apology need be offered for presenting to the British public the Biography of one of the most illustrious and successful Professors of that eminently useful science.

The distinguished founder of the Liverpool College of Chemistry, having acceded to the urgent solicitations of a numerous body of his personal and scientific friends, to issue a third edition of his excellent treatise on "The Influence of Chemistry in the Animal, Vegetal, and Mineral Kingdom," with a Biography of its Author, the latter task was kindly and ably undertaken by an eminent Member of the Bar, who, with literary requirements, has been enabled to combine an intimate acquaintance with the moral and intellectual character of the subject of his labours.

Without wishing to interfere with the prerogatives of the biographer, the writer of the preface, himself a London Practical Chemist, would venture to refer the extraordinary success of Dr. Muspratt, both as an original investigator and an exponent of the science which he cultivates, to the importance he invariably attaches to laboratory practice over mere theoretical reasonings and oral instruction.

Whilst the scientific character of Dr. Muspratt's pamphlet has been highly extolled by Dumas and Kane, its literary standing has been honourably attested by Dickens and Knowles.

THE BIOGRAPHY

OF

DR. SHERIDAN MUSPRATT, F.R.S.E.,

MEMBER OF THE ROYAL IRISH ACADEMY,

MEMBRE DE LA SOCIETE D'ENCOURAGEMENT,

PRINCIPAL OF THE COLLEGE OF CHEMISTRY, LIVERPOOL,

Author of Works on the Blowpipe; Qualitative Analysis for Laboratory Practice; the Influence of Chemistry in the Three Kingdoms, etc.,

BY A LONDON BARRISTER-AT-LAW.

Richard Brinsley Knowles.

To look into the inner lives of celebrated men and see the working of those powers which elect them from the multitude, has always been held a study refreshing and instructive to the mind. The missions of such men, their early indications of superiority, the growth of their faculties, and the fight which for the most part they had to wage, before they wrung their tribute from the indolence, ignorance or jealousy of the world, are features which have added to this study, in some sort, the charms of a romance. And very similar, if we think of it, is the relation which the mental workings of this class bears to those of ordinary intellects, to that which distinguishes the episodes of life from the common drudgery of every day. A wonderful thing it is to think that while there is hardly

a mind educated in any branch of science which cannot understand its discoveries when once they have been made, it is only to an individual here and there that it is given to throw light on the untrodden paths of science. It shews how immense is the superiority of a great over a little mind; and suggests how possible it is—arguing with mere reference to this disparity, for other testimony is more than ample—that an almost infinite series of orders of intellect may rise one above another in a supermundane economy, perhaps with even greater progress from inferiority towards that which is perfect or infinite. We believe that to some such reflection and to the conviction of weakness it produces, do we owe the humility which distinguishes those who *can* from those who only presume that they can. And were it only to establish this truth, and impress its caution, the study of Biography would be valuable. But it has other uses, and especially to the man, for instance, who feels by the evidence of willing encountering of difficulties, or of that definite thirst for the mysteries of an art, which is often the token of power to discover them, that he has the germ of superiority within him. To such an one it serves for encouragement—sometimes for inspiration—to tell him how the worthies of a past age, or the elder heroes of his own, have combatted their way to fame; how many hardships from within and from without they have conquered; how many obstacles beaten aside; how, in a word, they have thriven upon that persecution which difficulties create: thriven, not by dint of indifference to toil—for that is mere insensibility of which a superior man was never made,—but through a generous devotion to their art, which has, indeed, turned labor into ease, but not without much pain in the process.

We have not in the subject of the present memoir a man

distinguished for having overcome the ordinary difficulties that throng the path to celebrity. He has not issued into life through those pecuniary hardships which give strength to a good many superior minds, and ruin a great many more. But he has given, it may be, a better proof of ability, in undergoing the toil of an elaborate and abstruse science of whose material rewards he stood in no need. As a general rule the sons of affluent fathers have aspired to add to the insipidities of parliament, or to repose on the comforts of a rich living, or more commonly to squander in idleness what their ancestors acquired for them with a severe industry. Any of these "time-honored" courses he too might have adopted. But there was something in him which the beaten track would not satisfy. His youth had caught glimpses of a bright and almost magic world which a few brave minds had partially explored, and it became the ambition of his life to go along with them, or surpass them, if it might be, in this part-discovered realm. At an age when others were only stripping for their work he was already gaining ground: not tempted to exertion by a hope of wealth, nor urged by the spur of adversity, but, obeying the impulse of a love for science, which worked by the force of its intensity.

James Sheridan Muspratt is the son of Mr. James Muspratt, of Seaforth Hall, near Liverpool; well known for his success as a chemical manufacturer: a man of strong and original mind, and of an enterprising and liberal spirit. Of ten children the chemist is the eldest, and was born in Dublin on the 8th of March, 1821. His father's subsequent removal to Liverpool, where he soon surprised that busy world by the magnitude and success of his chemical works, placed his early education in the hands, first of the Rev. Mr. Hind, of Winwick, Lancashire; and

afterwards of Dr. Cowan, in the neighbourhood of Liverpool. Here he evinced a taste for chemistry and displayed considerable powers of memory ; a quality always valuable, but especially so in the science for which he now felt a waking ambition. At thirteen he travelled through France and part of Germany, and, on his return took the first step towards future achievements by repairing to the Andersonian University of Glasgow where for nine months he studied in the laboratory of Professor Graham, whom he afterwards followed to London when that gentleman took the chair of the late Dr. Turner, in the University College in Gower-street. About this period and before he reached the age of seventeen, he had already made sufficient progress to be entrusted with the chemical department at the works of Peel Thompson, in Manchester ; and also published a paper upon Chloride of Lime, which attracted considerable attention. Proceeding to America he there entered into a trading partnership, but soon discovered, by the loss of some thousands, that he was better fitted for the laboratory than the Exchange. The result was, that he retired from a field for which Nature had evidently not intended him, and terminated his American experience in 1842 by visiting the various States. Here, as elsewhere, he was well received, and particularly attracted the notice of Dr. Hare, of the University of Pennsylvania. He was now about to take the step which was to determine his future character and career.

From his travels through Germany, France, Italy and America, his mind had not only gathered strength, but proved that its early bias was a true one. Had it not been so, the various phases of life and occupation he had seen, would have converted him probably, with his advantages of fortune, into a mere gentleman of taste.

In the year 1843 he repaired to Giessen and placed himself under the great Liebig. It was not long before the Prince of Chemists recognized in his pupil that energy and ardent love for chemistry which afterwards created betwixt them the closer relationship of friendship. By his industry and talent the young student soon gained the admiration of all his fellow pupils, for whose emulation he supplied an example of indefatigable application. In Giessen he remained during two years, gaining golden opinions from all who were capable of estimating his worth. Will, Hofmann, Fresenius, Rosé, Berzelius, Kopp, Ettling, and Liebig, are amongst the celebrities who bear testimony to his labours at that time; and so pleased was the last to possess such a pupil, that he considered this a reward sufficient of itself, for the advantages of his instruction, and refused to receive the customary fees.

Having now spent some years in "educating" his powers, he resolved to test their strength and soon published a paper upon the Sulphites. This was his first public effort of any moment. It appeared in Liebig and Wöhler's "Annalen," was copied into all the Scientific Annals, and gained him his degree of Doctor of Philosophy, a title never before granted to so young a man. Until the appearance of this treatise little had been known about its subject though many distinguished chemists had taken it up. Muspratt was the first to prove the analogy of the *sulphites* and the *carbonates;* having also during his researches discovered many new salts. Berzelius has written—"The investigation of the sulphurous acid and its salts by Muspratt, is one of the most elegant and elaborate we possess, and, moreover, is one which beautifully sets forth the analogy and isomorphism between the sulphites and carbonates—a discovery *overlooked* by all previous investi-

gators." Then followed a paper on the "Pretended formation of Valerianic acid from Indigo," which was read before the British Association at York.

But these were merely preparatory to his after researches, which are amongst the most interesting in chemistry. In conjunction with Dr. Hofmann he discovered Toluidine and Nitraniline, two organic bases of the utmost importance. Of this discovery, the great French chemist, Laurent, speaks, as follows, in a letter to Dr. Hofmann :—"The production of Toluidine and Nitraniline interested me greatly, as I have for a long period been anxious to find Peroxide of Nitrogen substituting Hydrogen in an Alkaloid without its basic properties being destroyed; but I should not have supposed that it could have been accomplished. The formation of Nitraniline will therefore prove extremely important, and it reflects great credit upon the discoverers."

Whilst at Giessen, he edited Plattner's treatise on the Blowpipe, a work which in its English form bears the title of "MUSPRATT'S PLATTNER ON THE BLOWPIPE," the translator having made the treatise as much his own as Plattner's, by the many valuable additions he has introduced. Of this work the celebrated Will thought so highly that he refers to it in an especial manner when he pronounces Dr. Muspratt "one of the most distinguished chemists of the day." Speaking of him at this time Dr. Hofmann thus sums up his career at Giessen :—"Dr. Muspratt, in a comparatively short time, besides bringing out Plattner's renowned work on the Blowpipe, published two memoirs, establishing at once his intimate acquaintance with Mineral and Organic Chemistry. The first of these comprised the Sulphites, and the results obtained gave us an exact knowledge of these interesting compounds, which Berzelius has incorporated in the new edition of his Lehr-

buch. In the second, Dr. Muspratt showed the groundlessness of the assertion of a French chemist (Gerhardt) that Valerianic Acid is produced when Hydrate of Potash and Indigo are fused together. Dr. Muspratt knew well how to deal with this statement; he showed first, upon theoretical grounds, that such a metamorphosis was in a high degree improbable, and subsequently proved, after a close investigation, that the presumed Valerianic Acid was no other than Acetic. In some later investigations, new processes in which Aniline is formed; upon Toluidine a new organic base, &c., which were conducted by Dr. Muspratt and myself, I had repeatedly the opportunity of witnessing the assiduity and perseverance, and also the remarkable care and accuracy which characterised his labors in the course of these researches."

Let us pause a moment to admire the energy which had exhausted the instruction of three Universities—Glasgow, London, and Giessen, and achieved an European fame before twenty-four years of age!

In 1845 Dr. Muspratt left Giessen; and in the following two years visited various parts of Germany, in order to become personally acquainted with her distinguished men. This tour alone would have rewarded him amply for all the labors of his study; since everywhere he received the most flattering welcome from men of rank and learning. Rosé, of Berlin, assured him, on his presenting his letter of introduction, that "SULPHITE MUSPRATT needed *no* introduction."

In 1847 he again visited Giessen and spent four months in its Laboratory, discovering several remarkable bodies produced from the Sulphocyanides of Ethyle and Methyle. A paper on this subject was printed in Liebig's Annalen, as well as in the Chemical Society's Transactions. In 1848 he gave a paper on the Selenites; in 1849 he proved the

existence of Carbonate of Alumina, and also published some very interesting remarks in Liebig's Annalen on the Blow-pipe, reactions of Stontia and Baryta. In 1851, one of his greatest efforts appeared; his paper on Carmufellic Acid, a new acid from cloves. This treatise has been published in the proceedings of the Royal Society, and in the Philosophical Magazine. But the most important act hitherto of his life was, the foundation of a College of Chemistry in Liverpool.

Acting upon the truth that the noblest results of science are those which conduce most to the benefit of mankind, he has chosen for the scene of his future career a manufacturing district, in which he has opened up sources of practical knowledge, sources of inventions and improvements whose value will not only be felt at their centre but throughout the country. And how important is chemistry in our age even men who are not chemists can bear witness. If we look to our manufactures, its influence is there, cheapening and beautifying our operations, leading industry into channels through which the thoughts and labors of men flow now for the first time. It renews for us the fruitful qualities of the earth, exhausted by overworking, or multiplies them till crops are doubled, sometimes trebled through its aid; while in medicine, what has it not done for us? This is in addition to the wonder of the science itself!

A man, then, who devotes his time, his money—and which is more valuable than either—his experience, to place the advantages of such a science within reach of students of all kinds, and sits down to perform the duties of Professor in a non-scientific town, instead of taking his place, where he might, amongst the scientific magnates of the day, is entitled to another crown for the practical character of his ambition.

Baron Liebig lately wrote of him, "I learn with great

pride that you have gained the first position in England; continue in the same course, and you will be sure to keep it; believe me there is no one more interested in your welfare."

Learned bodies abroad and at home have recognised his claims. The Royal Societies of Edinburgh and Dublin elected him by a unanimous vote, and recently France announced him a member of the Societé D'Encouragement, one of her first scientific institutions. The following excellent and beautiful reply Dr. Muspratt sent the President. It is given for the purpose of shewing the style of the Liverpool Professor.

"Sir,—As art is illimitable, improvement acknowledges no point at which it may say to itself 'I must stop.' In that which seems perfect to-day, the examination of to-morrow discovers some demand for alteration or addition; so that the work which genius had laid aside as finished, it now takes up again as a subject for the renewal of labor. But human enterprise, in order to fulfil thoroughly its mission, requires, too frequently, something more to stimulate it than the mere anticipation of successful achievement. Effort is not unfrequently attended with contingencies which render it prostratingly painful, and entail a duration overpowering to even more than ordinary patience; and, consequently, stands in need of cheering, that it may not be utterly given over. Hence the demand so gloriously responded to by that society which has done me the honour to appoint me as one of its members—a society, the humane aim of which is to encourage those who, with truly Christian philanthropy, make it their ambition to devote their faculties to studies and experiments which have for their object the enlightenment, the exaltment, the usefulness, and the happiness of their fellow-creatures. To be deemed worthy of being enrolled in such

an association is, in itself, a reward for loftier merits than I can presume to lay claim to, though, from my youthhood, I have devoted myself independently, spontaneously, and zealously to the prosecution of science. It is therefore, with the deepest feeling of satisfaction and pride, and gratitude, that I accept the honouring distinction which the society, of which you are the worthy head, has been pleased to confer upon me, and which I cordially attribute more to generous kindness on the part of its members, than to any desert of my own. As it has been said by another, 'Such appreciation, proceeding from a foreign land, sounds like the distant plaudits of posterity.' —I have the honour to be, &c.,

SHERIDAN MUSPRATT, F. R. S. E., Dr. Phil., &c."

It must be confessed that Dr. Muspratt has no reason to complain of any slowness on the part of his cotemporaries to recognize the efforts he has made for the elucidation of chemical truths, the ability he has displayed, and the successes he has achieved.

It remains now to speak of him in his private capacity. He has already taken that sensible step which by no means detaching the mind from vehement pursuit of its views, provides it relief in the occupations of an interesting home. On his return from Giessen, in 1848, he married Miss Susan Cushman, who is also well known to fame by her admirable delineation of the lovely Juliet. Thus he achieved one of the happiest, if not greatest successes of life: and not without deserving it. For, to a mind peculiarly adapted for Chemical pursuits, nature has added for him the better gift of a disposition kindly, affectionate, and sincere. It is this fact which makes his prosperity a matter of such warm congratulations to his friends. They recognize it as something which in part belongs to them-

selves, for the sake of old times and anticipations with some, and of present friendship with others.

Hospitable, like the earnest and eminent man whose name he has immortalized, he inherits also his energy and simplicity of purpose. A cheerful companion, patient of others, and willing to add what he can in mirth and wit to a social hour. A punster whom Charles Lamb would have taken to his heart; and convivial, notwithstanding the fact that he has been a disciple of Father Mathew. In person he is above the medium height, strong set, and well proportioned. His forehead is fine and his countenance decidedly handsome. The portrait which accompanies this biography is taken from an excellent photograph by Beard*.

Here then is a brief sketch of half a life; whose principal epochs we have first touched and passed on, that we might not exceed our limit. Dr. Muspratt is now thirty years old, and when we consider how much he has done thus far, how reasonable is the hope that whoever has to write the second portion of his Biography will have even more honors to record. We see him already the author of several valuable papers, the discoverer of treasures without price in chemistry, and the founder of a College in which the science is taught by one of its best professors,—the founder himself. From all classes pupils come to him—each with a different aim perhaps—and when the period of their study is closed, they leave him with earnest and grateful testimonies, to the clearness of his instructions; to his untiring patience, and kindliness of manner.

* Bally, the distinguished phrenological artist, thus describes him—"You have one of the largest brains in proportion to your size, which constitutes a strong mind; rather slow to action, but when set to work, you will go through it with great energy—indomitable perseverance—you possess love of fame or approbation in a very high degree—above everybody in the profession—the moral faculties are very good . . . . "

THE

INFLUENCE OF CHEMISTRY

IN THE

ANIMAL, VEGETAL & MINERAL KINGDOM,

BY

DR. SHERIDAN MUSPRATT, F.R.S., EDIN., &c.

[THIRD EDITION.]

CHEMISTRY, says an able philosopher, is so often alluded to in modern writings, that it may perhaps be regarded as a problem of some importance to indicate more especially the influence of this science on the useful arts and on industry, as well as its relations to agriculture, manufactures, &c. Chemistry, as an independent science, offers one of the most powerful means towards the attainment of a higher mental cultivation; that the study of Chemistry is profitable, not only inasmuch as it promotes the material interests of mankind, but also because it furnishes us with insight into those wonders of creation which immediately surround us, and with which our existence, life, and development, are most closely connected.

It is so congenial to the ever-active human intellect to inquire into the causes of natural phenomena, and into the changes which we daily observe in all that surrounds us, that those sciences which give satisfactory answers to our inquiries exercise more influence on the progress of mental cultivation than any others.

Chemistry, as a part of the science of Natural Philosophy, is most intimately connected with physics; and this latter science is as closely related to astronomy and to mathematics. The simple observation of nature forms the foundation of every branch of natural science, and observation has only very gradually assumed the form of science. Thus the relation of light to the earth, the succession of day and night, and the variations of the seasons, gave birth to astronomy.

As the human mind advances in knowledge, from whatever source that knowledge may be derived, all its powers are strengthened and elevated; and its progress in all other directions thus promoted. The exact knowledge of the relation connecting certain phenomena, the acquisition of a new truth, is equivalent to a new sense, enabling us now to perceive and recognise innumerable phenomena, which remain invisible or concealed to others, as they formerly were to ourselves.

Without an acquaintance with the history of physics it is impossible to form any correct opinion of the effect which the study of nature has exercised upon the cultivation of the mind. In our schools mere children are now taught truths, the attainment of which has cost immense labour and indescribable efforts. They smile when we tell them that an Italian philosopher wrote an elaborate treatise to prove that the snow found upon Mount Ætna consists of the same substance as the snow upon the Alps of Switzer-

land, and that he heaped proof upon proof, that both these snows, when melted, yielded water possessed of the same properties. And yet this conclusion was really not so very palpable, since the temperature of the two climates so widely differ, and no one in those days had any notion of the diffusion of heat over the surface of the earth. When a schoolboy takes a glassful of liquid, and, placing a loose piece of paper over it, inverts the glass without spilling a drop of its contents, he only astonishes another child by his performance, and yet *this is the identical experiment which renders the name of Torricelli immortal.* It is a variation of that experiment with which Ottovon Guericke, the Burgomaster of Magdeburg, threw the Emperor and the Princess of the Empire at Ratisbon into speechless astonishment. Our children have more correct notions of nature and natural phenomena than had Plato! they may treat with ridicule the errors which Pliny has committed in his Natural History!"

I now commence with a few remarks upon the necessity of a practical study of Chemistry; a science which has, of late years, so rapidly progressed, and which can muster in its ranks some of the brightest intellects that have ever graced the world.* Chemistry is a science that can only be learned in the laboratory. By lectures and books we may obtain an insight into, and a very fair knowledge of, nearly every other science; but with Chemistry this is impossible. The most minute *description* of an experiment will not secure the student from encountering the numberless difficulties which will present themselves on his attempting to perform it by himself; and this is more par-

* I may cite Berzelius, Priestley, Cavendish, Boyle, Boerhave, Black, Scheele, Berthollet, Lavoisier, Davy, Dalton, Dumas, Liebig, Humboldt, Faraday, Wollaston, Mitscherlich, Rose, &c.

ticularly the case with regard to manufacturing processes. Though a person peruse over and over again the description of the fabrication of soda, gas, and sulphuric acid, and then endeavour to experiment, even on a small scale, still he will find himself beset with a host of obstacles almost insurmountable, and which, at the best, can only be overcome by months of diligent inquiry and manipulation. The absurdity of supposing, that a knowledge of Chemistry can be obtained from practical lectures must be apparent. As well might one hope to construct a delicate mechanical apparatus from hearing or reading a description of it. Thus, the laboratory is the only place where an intimate and beneficial knowledge of a science of boundless research can be obtained; for there, under the eye of the pupil, a variety of processes is in progress, from which he may, in fact, derive more benefit than from his own experiments. Chemistry has been justly pronounced a mine pregnant with inexhaustible wealth, whose ramifications are accessible to all who have the opportunity and industry to explore them. Experimental study, supplanting mere speculative philosophy, is working miracles on all sides. Every day is fertile in discoveries. Industry is in a state of perpetual progression, owing chiefly to the labors of the Chemist. I affirm, and my readers will no doubt coincide with me, that in no previous epoch in our world's history has every branch of industry undergone such a revolution as that which the last half century has accomplished; and this, in no small measure, through the investigations of chemical science. Were we to estimate the value of a science by its utility,—the standard by which it certainly ought to be judged,—we should be entitled to place Chemistry in the foremost rank. The Chemist is not the benefactor of a class, but the benefactor of a nation; for he draws from

their hiding-places the most precious secrets of nature, and turns them to practical and successful results; whilst the analyst opens to us the constituents of waters and substances, and proves upon which ingredient their effects mainly depend. When analysis reveals to us the composition of a mineral water, we may readily produce it with all its qualities, a fact sufficiently well established by the number of factories of mineral waters in all parts of the kingdom; and, when we are positively able to distinguish the ingredients actually efficacious in a water, we can prepare a much more active mixture than the native spring. We now employ iodine, instead of waters, in indurations and struma. It was the light of science that enabled us to connect certain effects on the human body with certain elements in the waters; and, as I have just stated, led us to the one active element alone. It would not become me, as we are discussing analysis and its power, to pass over the artificial formation of ultramarine; which, according to a distinguished philosopher of our time, is the most brilliant and conclusive achievement of inorganic Chemistry. Gmelin's analysis of lapis lazuli proved that it consists of silica, alumina, and soda, three bodies destitute of color, with sulphur and a trace of iron. Nothing could be discovered in it that would account for its deep azure tinge. From this it might have been supposed that the analyst was wrong, and that its artificial production was impossible; but the thousands of pounds weight which are now manufactured demonstrates the accuracy of the analysis, for the ingredients are combined in the proportions determined by Gmelin.

We shall now glance at agriculture, the most important branch of human industry, and descant for a short time on the enormous benefits it has received from science. In

1840, when a new work on agriculture was first published, persons talked of guano as *a rare curiosity*, but when the views of the Author were opened, and disseminated, its use became general. That manure, which consists of the excretions of millions of seabirds for thousands of years, we now employ to enrich and fertilize our own soil. The farmer has obtained incalculable assistance by tilling the soil on scientific principles. It is now an admitted fact, that, to keep up the fertility of the soil, we must restore to it those inorganic matters which have been removed from it in the crops; and the most striking illustration of the advantage agriculture has derived from Chemistry is the success that has attended the search for mineral manures. Large quantities of phosphate of lime have been discovered since our attention was directed to its importance; and, by mixing that mineral with sulphuric acid, it is reduced to such a state that it can be most easily assimilated by plants of the most delicate structure. This beautiful prescription of science provides an immensity of food for the vegetal kingdom, at a very moderate cost. Chemistry has proved to us the loss that takes place in all our farmyards, and the waste of valuable matter swept away in our rivers. This has forced companies to start up for its collection. All recrements of a fertilizing nature will in time be carefully collected and applied to the field; and, as science advances, the results of our lands will be calculated with as much certainty as those of our laboratories. The most striking instance, in point, is the perfect success of some experiments that were performed by the Rev. Mr. Huxtable, at Sutton, Waldron. The problem he sought to solve was the following:—Can we, by supplying to the soil the constituents of a plant, cultivate that plant on any land, howsoever sterile in itself? He selected for the purpose

about five acres of the most barren and unlikely soil in his neighbourhood; such, in fact, that to grow swedes upon it was regarded as impossible by the farmers in his district. Chemical analysis pointed out to him, that, to produce 20 tons of bulbs and 5½ tons of tops, nearly 5 cwts. of inorganic matter, consisting of 146lbs. of potassa, 76lbs. of soda, 69lbs. of sulphuric acid, 30lbs. of phosphoric acid, 103lbs. of lime, 22lbs. of magnesia, 23lbs. of chlorine, and 23lbs. of silica, would be required, as well as a certain amount of organic matters, consisting of ammonia and carbonic acid. A mixture of the above was made, and the issue exceeded the rev. gentleman's most sanguine expectations. This proves that with a skilful employment of labor, reliance on the principles of Chemistry, and adequate capital, there is no soil, how poor soever, which will not abundantly repay the costs of cultivation. The whole human race is particularly interested in the scientific progress of agriculture, as so great an amount of the fixed capital of the civilized world is employed in the cultivation of the soil.

In the animal kingdom we have every reason to believe that Chemistry will, ultimately, resolve the most exalted problem with which the human intellect can be engaged—the laws of vitality. What an enormous amount of empiricism has it not dispelled from the healing art? In the words of a talented Chemist, that invincible weapon analysis has cut through the mantle of prejudice and error in which the medical agents of the art had been so long enshrouded: the true ingredients and offices of the various parts of food have been disclosed by its all-powerful agency, and the constitution of the diseased and healthy organism has, in a great measure, been unfolded to us by its irresistible power.

We no longer drive a nail into the walls of our churches

to stay the pestilence with which we are visited. We do not now believe that a particular drop of water is sufficient to arrest the progress of the plague. The accumulated rust of ages has, during the last half century, been dissipated by a Berzelius, a Mitscherlich, a Dumas, and a Liebig, aided by a host of eager scientific Chemists in all parts of the world. These have been the grand pioneers, and through them more has been effected in fifty years than the crude experimentalists of a great many antecedent centuries had achieved. What assistance has the fattening of cattle derived from the counsels of the Chemists? But those counsels have not been confined to cattle alone; the principles of nutrition are now extending constantly for the benefit of the human race. In the work, *Researches on the Chemistry of Food*, I find the following pertinent remarks:—"If we consider with some attention the facts which have been ascertained in animal Chemistry we shall be surprised to find how few among them there are on which conclusions can be securely based. The cause of this, as appears to me, is, that hitherto but a very small number, comparatively, of professional Chemists have occupied themselves with the cultivation of the science, or have selected it as the object of profound and thorough investigation." Liebig, with a few others, has sunk a new shaft in this direction. He has pointed out to us, after making grand discoveries, the manner in which our excavations should be made. We must hope that his advice will be followed, so as to enable us to strengthen and mature the rising generation, and still further to alleviate the sufferings from disease. The principles of physiology, laid down by this Chemist, are daily tested, with advantage, in the wards of our infirmaries. He is a directing spirit in organic Chemistry, which *alone* places him in the most

elevated rank among those who may be termed the benefactors of our race.

Let us now enter upon the mineral department, and the assistance afforded by science in Chemical manufactures. In taking a brief retrospect of the vast progress the arts and manufactures have made during the last half century, our attention is at once directed, more particularly to three branches, which stand out so conspicuously, I mean coal-gas, sulphuric acid, and soda. It is most interesting to trace the applicability of gas to its origin. The elimination of inflammable gases from the earth in various parts of the globe has been known for ages; the most familiar instance in this country being the fire-damp of the miners. Jets of flaming gases, bursting out from the ground, have attracted notice from a very early date, so that the savage tribes, owing to the grandeur of the spectacle, apparently unsupported by fuel, considered the spots whence such emanated as the abodes of their gods. The well-known holy fires of Baku still burn, and are due to the ignition of light carbide of hydrogen with some naptha vapor. They are worshipped by the savages in the neighbourhood of the Caspian Sea.

In China the borers for salt water often meet with streams of combustible gases, which they use for illuminating factories and evaporating brines; consequently, the Chinese were acquainted with the uses of coal-gas long before the knowledge of its application was acquired by Europeans. The idea of imitating the natural processes, and of employing the gases thus obtained for useful purposes, originated in this country nearly two hundred years ago. To Dr. Clayton, the Dean of Kildare, the honor is due of having first obtained gas from the distillation of coal. The gas produced by the distillation of coal is not uniform

in its composition. Its illuminating constituents are light carbide of hydrogen and olefiant gas, but many other gases are evolved during the process, most of which tend to diminish the illuminating power; whilst others, such as ammonia and sulphide of hydrogen, are injurious to health. By the assistance of Chemistry the composition of coal-gas was elucidated, and the nature of its poisonous and useful ingredients ascertained. The Chemist, therefore, gave, on this knowledge, means to the manufacturer for separating the deleterious compounds. By the process of purification the cyanogen compounds, with the sulphide of hydrogen, ammonia, sulphurous acid, hydrochloric acid, and carbonic acid, are arrested. Scientific improvements are still going on with relation to gasworks. From coal naptha a number of interesting oils have been lately separated, which have long been favourites with the cultivators of organic Chemistry. Benzol,* one of them, is so readily vaporable that, when common air is passed through the tank containing this oil, it becomes so highly charged with carbohydrogen as to burn with a brilliant light. This, I have no doubt, will ultimately bring benzol into more general use. The consumption of gas is enormous. The following statistics give us an insight into the extent which this branch of industry has attained. In England 6,000,000 tons of coals are annually employed for the manufacture of gas, and from 12,000,000 to 15,000,000 pounds sterling expended in its production. In London alone 500,000 tons of coal are annually used, producing 4,500,000,000 cubic

* Drs. Muspratt and Hofmann produced from Dinitrobenzol the most extraordinary organic alkaloid—Nitraniline.—*Chem. Soc. Trans.*, vol. 3, page 114. An eminent French chemist has written, "The formation of Nitraniline will prove extremely important, and it refleets great credit upon its discoverers."

feet of gas, and 500,000 chaldrons of coke; of the latter, 125,000 chaldrons are consumed in manufacturing the gas, and the remainder sold for fuel. Upwards of half a million houses in London burn gas, and the length of the main arteries for conveying it is 1,600 miles. The capital employed in the metropolis for the production of gas is £4,000,000. The manufacture of coal-gas for the purpose of illumination affords one of the most striking instances of the triumphs of science when enlisted in the divine cause of civilization. Looking at it as a whole, and regarding the ingenuity evinced in the construction of apparatus,—the Chemical skill and beauty displayed in the process, and the very valuable purposes to which it is applied,—it forms one of the most beautiful, curious, and useful of our manufactures; and probably there is no subject of a manufacturing character in the present day which more engages public attention; coal-gas having now become not a mere luxury, or even convenience, but an absolute necessary. In the words of my friend and late colleague, Dr. Hofmann, "The extent to which the use of gas has affected the arts and manufactures in this country can only be conceived by those who are aware of its innumerable applications in the double capacity of giving heat and light. To our experimental Chemists the benefits afforded by gas cannot be overrated, more especially in England, where the price of spirits of wine is so exorbitant. But for the use of gas, in the laboratory, the progress of Chemistry in this country must have been greatly retarded.

"In speaking of the general influence of the manufacture of coal-gas, it is impossible to leave unnoticed the number of hands daily engaged in raising whole strata of coal, in loading and navigating the fleets employed in conveying it, not only to the different parts of this kingdom but to

foreign countries, which consume a larger quantity of English coal for the production of gas than is generally known. The extension of the gas enterprise produced a sensible effect on the ironworks by the vast number of retorts, the stupendous gasholders, and the endless pipes required for generating, storing, and conveying it.

"Several other branches of trade were also forced into increased activity, and even new trades sprung up in consequence of the extended use of gas. The substances produced in the purification of gas naturally attracted the attention of the gas manufacturer; and Chemistry soon pointed out valuable purposes to which they might be applied. The oily matter which separates, as a secondary product, in the distillation of coal, yielded, when purified, in its more volatile portion, the most convenient solvent for caoutchouc. Another part of it was found to be an efficient preservative of timber, and the pitchy residue formed the chief ingredient of an excellent substitute for the flag stones of our pavements, while the ammoniacal liquors were found useful in improving the fertility of land. Thus, after the lapse of countless ages, was the nitrogen of petrified fern forests resuscitated in the ammoniacal liquors of the gasworks, to vegetate once more, and increase the produce of our cornfields."

Soda and sulphuric acid belong to the products of Chemical industry applied in its most extended scale. The amount of the former used has been stated to be a fair criterion of a nation's civilization, and the quantity of sulphuric acid produced, in a country, is a good standard whereon to estimate its commercial prosperity. Sulphur is a most important element, but to the casual observer it is seldom regarded in this light. It is an essential ingredient of animal and vegetal fibrine, albumen, and caseine,

consequently indispensable to animal and vegetal life. It is used to a very great extent, both externally and internally, in Medicine, but its great importance is its conversion into sulphuric acid, of which article above 100,000 tons are now annually manufactured in Britain. Sulphuric acid is engaged for a variety of purposes; being the strongest acid we possess, it is employed to dispel other acids from their saline combinations. It is used, as I have before mentioned, in liberating phosphoric acid from bones; hence its importance in agriculture. Phosphorus is manufactured by its aid, which thus ministers to our comfort by substituting the convenient lucifer matches for the crude tinder-boxes of old. It is also employed in the manufacture of alum; the sulphates of copper, zinc, and potassa; in that of sulphuric ether; of sugar by the saccharification of starch; in the purification of gas; and in the new and beautiful refining process; also for generating hydrogen, for the oxyhydrogen blowpipe in cementing lead, doing away with the necessity of solder, &c.; but its vast consumption is in the conversion of sea salt into sulphate of soda for the manufacture of the "soda" of commerce. Soda has been used from time immemorial in the fabrication of soap and glass; two Chemical productions employing and keeping in circulation an enormous capital; but its consumption at the present time in the manufacture of these two articles is immense, about 60,000 tons annually. The sea salt or chloride of sodium, of which about 100,000 tons are yearly consumed in the soda manufacture, is obtained from brine springs; the principal ones are in Cheshire. Brine was formerly evaporated spontaneously, but as "necessity is the mother of invention," the salt is now crystallized, in quantities, from the brine by artificial means. The present method of making soda from common salt was discovered by Leblanc,

but it was some time before the process was adopted in this country. At first the duty on salt checked the full advantage of the French Chemist's invention, but when the government repealed the duty, and salt could be bought for ten or twelve shillings the ton, the production of soda has been constantly on the increase. Soap, instead of being a luxury, is now accessible to all; and glass, which used in ancient days to be looked upon as a gem, has now become a necessary of life. The amount of soap annually exported from Liverpool exceeds the quantity shipped in any one year from all the British ports previously to the conversion of common salt into the "soda" of commerce; and, moreover, in 1820, 9,000 tons of barilla were imported into Great Britain; last year there was not one ton. Sulphuric acid is manufactured by burning sulphur in kilns, oxidizing the sulphurous acid formed with nitric acid, which process, alone, led to the discovery of immense magazines of nitrates in South America.

The nitric acid is now exclusively fabricated from nitrate of soda, the nitrate of potassa being used in making gunpowder, and for the purposes of agriculture. One of the most glorious triumphs which Chemistry has of late years accomplished, is the substitution of sulphur minerals in our country, for the native sulphur of Sicily. Owing to the King of Naples exacting a duty of £4 per ton on all the sulphur leaving his dominions, we rendered ourselves independent of Sicilian monopoly; and were we deprived of pyrites to-morrow from any cause, we would certainly discover a cheap mode of extracting sulphur from gypsum, a mineral largely distributed in all parts of the world. "This clearly shows that in industry and commerce every imprudence carries with it its own punishment, every oppression immediately and sensibly recoils upon the heads

of those from whom it emanates."

The monarch of Sicily, finding the injudicious impost on sulphur almost destroyed the commerce of one of the most important provinces of his kingdom, has taken the export duty off sulphur; so that the quantity we now import is more than it was five years ago; and, only for the revolution in Sicily, sulphur would be as cheap as it ever had been. At present the price is high on account of a limited supply.

If the King had not interfered, of course the production would have increased in a greater degree, and the importation at present be nearly doubled. The artificial production of soda has given a new impulse to another flourishing branch of industry: bleaching by means of chloride of lime. The muriatic acid, evolved during the conversion of chloride of sodium into sulphate of soda, has until lately escaped into the air, but now it is to the interest of the Chemist to collect it, and to mix it, in stills, with peroxide of manganese. By this process it yields up its chlorine, which is conducted into chambers, to be absorbed by lime, forming bleaching powder, now shipped in casks to all parts of the globe.

I have endeavored in this paper to show the influence of Chemistry in the animal, vegetal, and mineral kingdom, by selecting prominent examples in each department. Improvements are continually being made in this noble science, and every discovery in it tends to bring forth fruits of universal usefulness. The connexion between medicine and Chemistry is daily becoming more intimate, and, consequently, much may be expected from their amalgamation. The miner and metallurgist are continually seeking the assistance of the Chemist, and availing themselves of the results of his researches; and that

valuable instrument, the blowpipe, is now an unraveller of some of their most difficult problems. Pharmacy is improving, owing to its followers assiduously cultivating Chemistry; and with reference to the important subjects of medical jurisprudence and toxicology, it seems sufficient merely to advert to them to suggest immediately to the mind the most cogent reasons for cultivating a science, without which we must be incompetent to afford assistance in cases of emergency, or to detect accident or crime whenever the life of a fellow-creature has been sacrificed, or is at stake. Chemistry qualifies us to detect adulteration and imposition; and, in short, is so palpably essential that no man can now-a-days be considered a properly educated Pharmacopolist who is not sufficiently versed in it to be able to give a satisfactory account of the articles in which he deals. Lastly, "the searching into the works of Nature, while it delights and enlarges the mind, and strikes us with the strongest assurance of the wisdom and power of the Divine Architect in framing for us so beautiful and well regulated a world, it does at the same time convince us of His constant benevolence and goodness towards man."

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